Designing Multimodal User-Interfaces for Effective E-Learning in the School Primary Stages Applied on Real Fractions

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Abstract—this contribution focuses on the development and design of e-learning tools for school students in primary stages through dealing and considering the math of real fractions, which presents an example of learning material difficult to understand by many school students and a real challenge for e-learning designers and multimedia authoring. Firstly, we will highlight several problems facing school students and teachers caused by the traditional learning approach. Then, we are going to discuss some aspects related to e-learning, the major theoretical issues of educational psychology and e-learning with various modalities related to our work, and the classification of the interactive multimedia methodologies adopted in this work. Furthermore, the software-ergonomic and –architectural features of the developed e-learning tool will be introduced. Finally, the paper will conclude with a brief summary of a usability testing carried out to compare the developed e-learning user-interface with the traditional learning approach.

Index Terms—E-learning Tools, Human-Computer Interaction, User-Interface design, Usability Testing

I. INTRODUCTION

HIS contribution will not only focus on how e-learning software tools for school students in primary stages can be software-technically and ergonomically designed and implemented, but it also proves that e-learning tools are beneficial for students in primary stages through usability testing. The math of real fractions is selected as an example for learning material because of the fact that several school students in primary stages face enormous troubles in understanding this kind of math on the one hand, and it represents a big challenge for e-learning designer to transform the traditional learn material into multimedia-based computer presentation on the other. It is of great significance to discuss the traditional method of teaching mathematics, how it negatively affects students, and how it contributes to their tendency to poor achievement in mathematics. In a traditional classroom setting, the teacher will begin class by answering questions from homework, then he/she will teach the new lesson, and finally he/she will give a homework assignment that students may be able to begin working on in class if time permits. This method is often boring since only job for students in the classroom is to passively sit and watch the teacher working on mathematics problems on the board. The students in class watch, listen, and copy, so that they begin to feel that mathematics is pointless and of little value to them in real life. It becomes a school subject they are forced to study, but one that is useless to them in real life.

In the traditional classroom setting discussed above, both students and teacher are often frustrated because students' individual needs not considered. Students generally have difficulty in listening and copying a problem from the board at the same time, so when they begin working on assigned problems at their desks, they encounter difficulties. Students raise their hands for help, and the teacher moves around the room trying to answer everyone's questions. However, he/she cannot get to every student before time to leave. Students leave the classroom without having questions answered and unable to complete the assignment. The teacher is exhausted from moving about the room in her effort to answer all the questions, and he/she is discouraged that she cannot effectively meet the needs of her students. Also research confirms that pressure of timed tests and risks of public embarrassment have long been recognized as sources of unproductive tension among many students. Three practices that are viewed as regular part of the traditional mathematics classroom causing great anxiety in many students are imposed authority, public exposure and time deadlines. Although these are a regular part of the traditional mathematics classroom, they cause a great deal of anxiety. Teaching methods, therefore, must be re-examined. Consequently, there should be more emphasis on teaching methods which include fewer lectures and more student involvement that can be achieved through introducing unconventional methods into the mathematics teaching process.

Studies have shown students learn best when they are active rather than passive learners [1]. The theory of multiple intelligences addresses the different learning styles. Lessons are presented for visual/spatial, logical/mathematics, musical, body/kinesthetic, interpersonal and intrapersonal and verbal/linguistic. Everyone is capable of learning, but may learn in different ways and thus lessons must be presented in a variety of ways. For example, different ways to teach a new concept can be through visual aids, hands on activities and technology. Learners are different than they were forty years ago. These learners today ask questions like why something is done, why this way or that way and why not this way; whereas, years ago learners did not question the why of math concepts; they simply memorized and mechanically performed the operations needed. Mathematics teachers today are eagerly trying alternative methods in an effort to better meet the needs of their students. We want our students to do mathematics, not listen to and watch mathematics being done by the teacher. We want our students to be motivated about doing and understanding mathematics, pass their classes, and stay in school. They should be prepared to accept integrating new technology, which they are very interested in the learning process along with solving problems that they recognize as relevant to their lives. Some effective alternative methods currently in use for teaching mathematics are cooperative learning problem solving experiences, use of technology, use of manipulative, and student projects. Use of technology is the method we plan to discuss today.

Today, there are many available modules for teaching mathematics using computers that tackle the issue of presenting mathematical concepts using interactive visual or multimedia aids. What we want to do in our modules is to tackle the issue of solving math exercises in an interactive manner using the computer as a tutor through a variety of math exercises modules that use an Arabic interface to present both exercises for the student to solve and a platform to enter exercises and solve them. Then, the computer corrects these problems and indicates to the student whether or not the solution was right. There are many advantages for learning via educational multimedia programs: Learning will take less time when multimedia instruction is used, teaching costs will be reduced and efficiency will be improved. Moreover, availability and flexibility of teaching resources can be increased.

To test the methodology and techniques developed in this research, a full functional e-learning education system for school students in primary stages has been implemented. In a further investigation, the usability system was tested and compared with traditional learning methods [2]. Later, some implementation aspects, both software-technical and ergonomic, will be covered in this part of this contribution. The proposed educational e-learning system is programmed by means of JAVA [3], [4], where objects consisting of software and graphics have been first built, leading to unified exercises. In addition, the e-learning system allows several kinds of presentations with distinct interaction styles for teaching real fractions using pie-charts, rectangles and so on. It also uses multimodality in mediating information for the students, such as presenting exercises by graphics and prompting the students to fill-in the corresponding fractions of the visualized pie-chart.

Several human-computer interaction rules for user-interface design have been taken into account when having implemented the e-learning system, such as consistency of data display (labeling and graphic conventions), efficient information assimilation by the user, minimal memory load on user, compatibility of data display with data entry, flexibility for user control of data display, presentation of information graphically where appropriate, standardized abbreviations, presentation of digital values only where knowledge of numerical value is necessary and useful [5]. The usability of the developed e-learning system has been compared against the traditional learning books (textbooks), through a comparative evaluation, in which fifteen male and female students learning at schools in Ramallah district were involved. They were divided into two groups of eight and seven students, so that during the comparative evaluation, both groups had to solve mathematical problems based on the two approaches. The raw data of the experiments have been handled statistically by using the Student's test or abbreviated as t-test [6] and then analyzed by SPSS [7]. The usability test allowed us to find that the e-learning education system is superior to the traditional approach. The two approaches were compared with each other by means of an experimental testing, in which some selected usability criteria, such as transparency, confidence, effectiveness etc., have been used.

II. THEORETICAL DESIGN ISSUES OF E-LEARNING SOFTWARE FOR PRIMARY SCHOOLS

E-learning involves the use of a computer or electronic devices, such as mobile phones, that can be seen as the delivery of learning, training or educational program by electronic means. Business oriented e-learning providers admit that they primarily offer training online that is delivered in a synchronous (real-time) or asynchronous format [8]. Jones [9] proposed that ICT[1]-based technologies, such as e-learning, digital learning, computer enhanced learning, no matter which tag is applied, all aim to exploit web-based technology to improve learning for students. Introducing e-learning for students in primary stages leads to several benefits and advantages: it helps moving beyond geographic boundaries; it gives the families the power to choose to teach their children wherever and whatever they wish; it ensures the availability of high-quality educators for all children; it provides technologies to assist students with special needs; it offers online courses; it establishes methods and procedures to encourage; it makes the availability of virtual schools and other opportunities for students to earn credit for taking a wide variety of classes online. E-learning can be achieved by many technologies such as television, video, internet etc., but we are mainly interested here in the desktop applications that resemble our e-learning education system which can be easily turned into a web-based application described later in this contribution. Web-based or internet applications are designated as on-line means which have , as mentioned above, two types of technologies, synchronous and asynchronous; where in the first one both teachers and students can meet in arranged classes online or at the same time. Real time two way text-based online chat and virtual classrooms are known types of synchronous electronic communication. LaPointe and Barrett [10] interviewed students, teaching assistants, and teachers of an online English as second language program based in Taiwan, using grounded theory to begin generating a theory of language learning using this new technology. In the asynchronous e-learning, users can control their own timetables and fit learning around their other commitments. Email, collaborative learning forums, text chat or forums, simulations, virtual laboratories are known communication technologies in asynchronous e-learning. We can briefly state that in the multimedia-based e-learning approach, either locally or remotely delivered, education or training courses are conveyed to remote locations via synchronous or asynchronous means of instruction. These means include written correspondence, text, graphics, audio- and videotape, compact disk-read only memory (CD-ROM), online learning, audio- and

[1] ICT: Information and Communication Technologies

videoconferencing, interactive television, and facsimile (FAX) [11].

Instruction and learning almost always go side by side, where the term instruction should be viewed as the creation and use of environments in which learning is facilitated. A successful model of instruction contains these phases of instruction: presenting information, guiding the learner, practicing and assessing learning [12]. There are eight methodologies of interactive multimedia (IMM) for facilitating e-learning: tutorials, hypermedia, drills, simulations, tools and open-ended learning environments, tests, and web-based learning. It should be noted that the e-learning software developed in this research is a mixture or a combination of tutorials, hypermedia, tests, and web-based learning. Tutorials and hypermedia are e-learning tools that mainly focus on the first two instruction phases; whereas, tests concentrate on the last instruction phase, the assessment phase. Web-based learning, which is able to foster any of the instruction phases, can be combined with any of these other methodologies. Historically, behavioral psychology and learning theory contributed to developments in the learning fields, such as programmed textbooks, classrooms based on token economics [13]. While the dominance of behaviorism began to wane in the last third of the twentieth century, cognitive psychology began to overtake during the 1970s as the dominant paradigm of learning psychology. Several issues of the cognitive theory such as perception and attention, encoding of information, memory, comprehension, active learning, motivation, locus, mental models, meta-cognition, transfer of learning, and individual differences [14], are most important to multimedia-based design of e-learning software. These cognitive aspects are most of what important when designing and evaluation multimedia-based design of e-learning software [15]. Alessi and Trollip [12] emphasize that the appropriateness between multimedia and design of educational software, on the one hand, and e-learning application types depends finally on the experience of educational tools developers on the other hand. While some mathematical concepts may be learned best via constructivist laboratory activities, some other math skills must be learned at a level of automation in a more directed fashion. While drills are suitable for languages, anatomy and web-based hypermedia materials that fit learners doing research, tools for exploring geometry or science, like the educational tool developed in this research, are useful for constructivist laboratory activities that are based on the constructivism approach to teaching and learning. In such environment, the cognitive-based learning of the students is the result of mental construction, through fitting new information together with what they already know. The context in which an idea is taught and the students' beliefs and attitudes influence this kind of learning techniques.

III. HUMAN-COMPUTER INTERACTION AND SOFTWARE ARCHITECTURE

A. *User-interface of the e-learning tool*

In our software module which presents an asynchronous e-learning type, we divided the different modules over grade levels. For example, the regular fractions module was divided on primary grades from presenting concepts of fractions, visually using circles and rectangles in the second grade until doing regular fractions multiplication and division in the sixth grade. This was done to adapt our software to different primary grade levels thus introducing the concept of regular fractions smoothly and gradually. On graphical user-displays, the readability of text colors depends on the background color. The simplest approach to designing readable colors on a screen is to use the principal complementary color as the background for text, through using the "color wheel" (Fig. 1) with opposite colors equal to (1-R, 1-G, 1-B) [16]. This color principle was utilized whilst having designed the graphical user-displays of the e-learning tool.

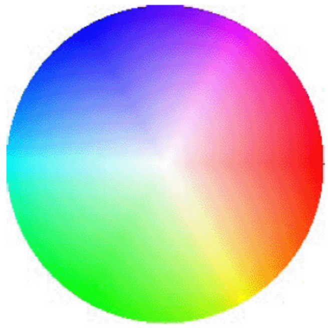

Figure 1. Color wheel

We start the introduction of the regular fractions module in the second and third grades where we introduce the concept of a fraction using visual aids based on geometrical shapes such as circles and rectangles. Supported are three different types of exercises with distinctive interaction styles:

- The first provides a picture of the fraction and the student is asked to enter the value of the fractions as illustrated in Fig. 2, which shows a display prompting the student to fill-in the corresponding fractions of the visualized pie-chart.
- The second provides a fraction and the student is asked to represent it visually by coloring sectors of circles or parts of rectangles. Fig. 3. illustrates a snapshot of the e-learning education system while presenting a display, which prompts the student to color the circle sectors which must correspond to the presented value of the fractions
- The third type deals with fraction comparisons where the computer gives the student the value of the fractions and the student has to represent both visually and then compare using the visual representation if the first fraction is less than, equal to, or more than the second fraction. Fig. 4. Illustrates a snapshot of the e-learning education system while presenting a display, which allows the student to solve the exercise visually and then compare the results by selecting the suitable relational or equality operators via a pull-down menu.

In each of these exercises, the computer generates a value of the denominator which can be controlled. After finishing the previous stage, the student can move on to the 4th grade, where the following types of exercises are possible:

- The first type introduces the concept of fraction equivalence in a visual manner where the student is given to fractions in which the second fraction is missing the numerator and he has to color the first fraction then color the second fraction to be equivalent to the first then fill in the numerator of the second fraction as shown in Fig. 5..
- The second type deals with the comparison issue using non visual methods and here we have two types one that deals with fractions (see Fig. 6.) and the other deals with fraction numbers (see Fig. 7.).
- The third type of exercises introduces the concept of regular fraction addition (see Fig. 8.) and fraction number addition as illustrated in Fig. 9..
- The third type of exercises introduces the concept of regular fraction subtraction (Fig. 10.) and fraction number subtraction (Fig. 11.).
- Then, in the fifth and the sixth grades, we introduce the following types of exercises:
- The first type introduces the concept of regular fraction multiplication (Fig. 12.) and fraction number multiplication (Fig. 13.).
- The second introduces the concept of regular fraction division (Fig. 14.) and fraction number division (Fig. 15.).

In all the above exercises on real fractions, we have two modes of operation one in which the computer provides the fractions. In this case we can also control the range of the denominators given by the computer; or the mode in which the student supplies the fractions. Also, as it can be seen, by examining the figures of the exercise we see that solving it demands to follow a systematic line of steps which helps the student to follow in solving any type of exercise.

B. Software-technical implementation of the e-learning system

- In order to program our modules, we have used the JAVA programming language where we have first built units that help the exercises look identical. The following units have been designed and implemented to be the building blocks of our exercise system:
- A circle class where you can draw a circle with any given number of sectors and that responds to mouse events to color and un-color these sectors.
- Rectangle classes that can be divided into any number of given rectangles that also respond to mouse events to color and un-color the internal rectangles.
- An Arabic numerals text field in which all the typed numbers appear in Indian numerals.
- A fraction field that has a numerator and a denominator to enter the values to.
- A grading panel to help grade the exercises, and to provide other control functions such as sound and help and a timer for the exercise.
- Utility classes to calculate GCD (Greatest Common Divisor) and SCM (Smallest Common Multiple) etc.

Then using the above mentioned basic building blocks along with other java classes, we have built each of the exercise units as a panel which can then be implemented as an application as is in our software; or to be easily implemented as an applet on an internet site which forms a web-based learning. And that was one of the prime reasons that we have used java for. Also, being programmed in java, our exercises can be implemented on multiple operating systems such as Windows, Linux, and Macintosh etc. as a direct result of that JAVA is architecture neutral. In addition, these basic building units will help us interact with teachers to get ideas for other new exercises to be implemented in the future.

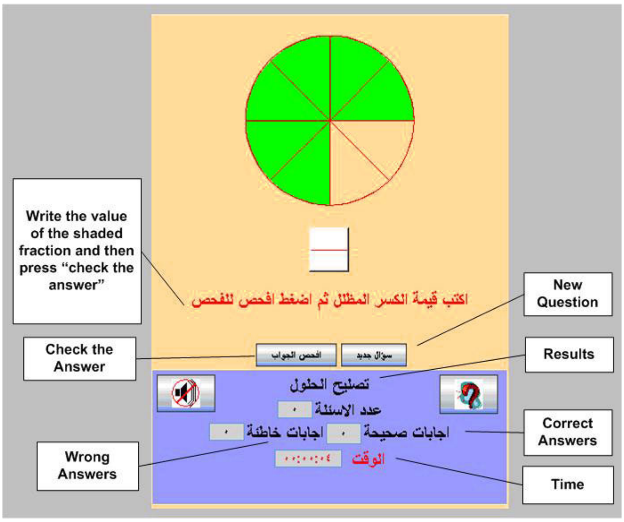

Figure 2. Filling-in the corresponding fractions of the visualized pie-chart.

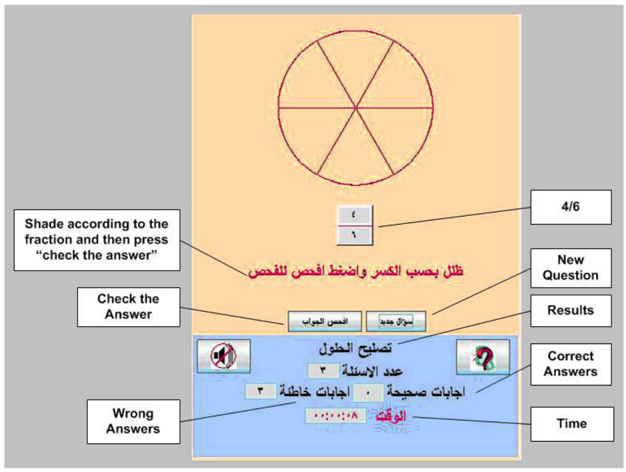

Figure 3. The student must color the circle sectors which must correspond to the presented value of the fractions.

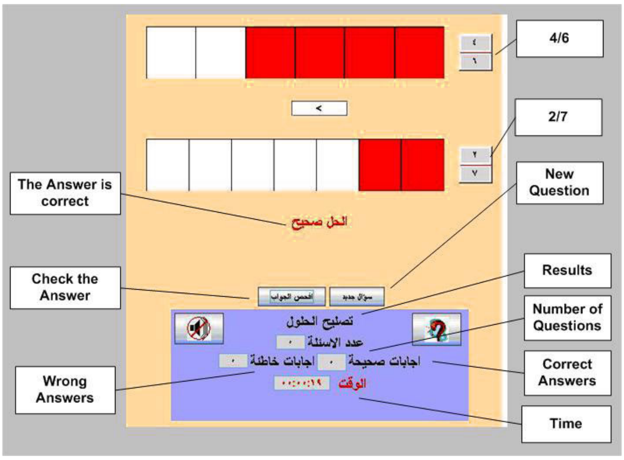

Figure 4. Enabling the student to solve the exercise visually and then comparing the results by selecting the suitable relational or equality operators via a pull-down menu

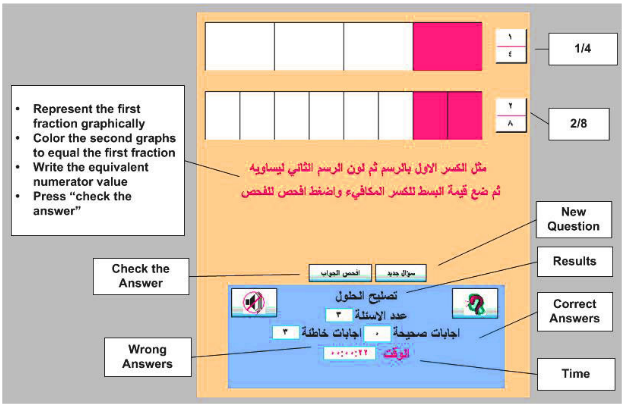

Figure 5. Introducing the concept of fraction equivalence in a visual manner.

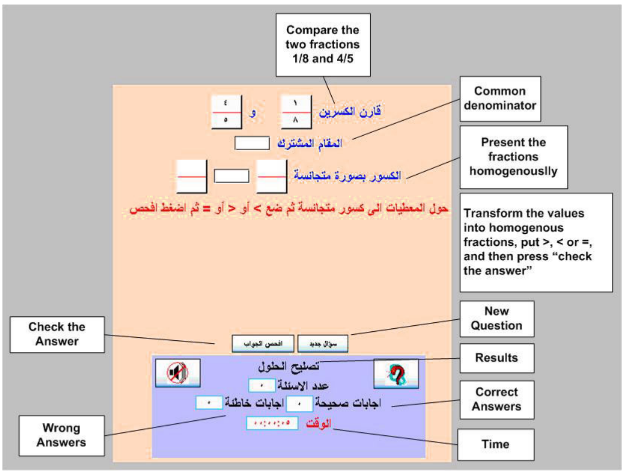

Figure 6. Comparison issue using non-visual methods using fractions.

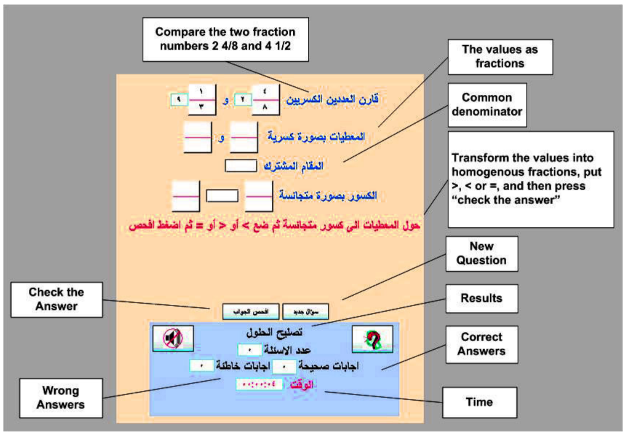

Figure 7. Comparison issue using non-visual methods dealing with fraction numbers.

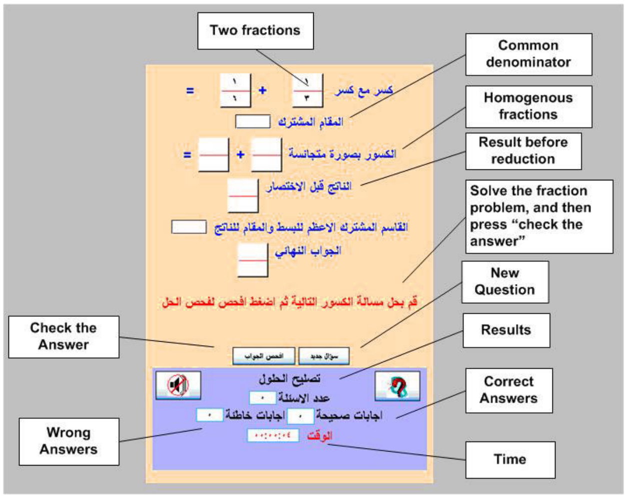

Figure 8. Regular fraction addition.

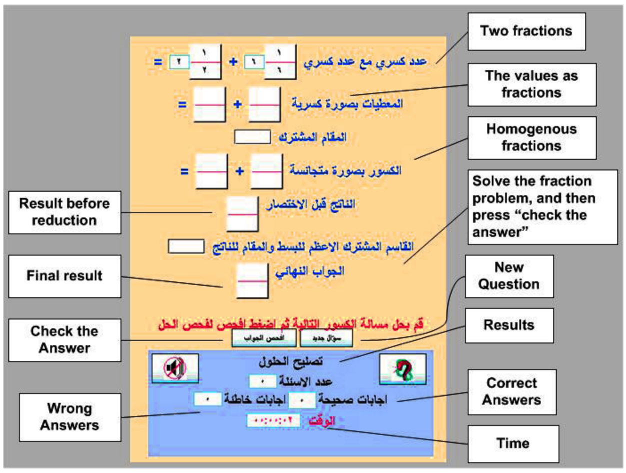

Figure 9. Fraction number addition.

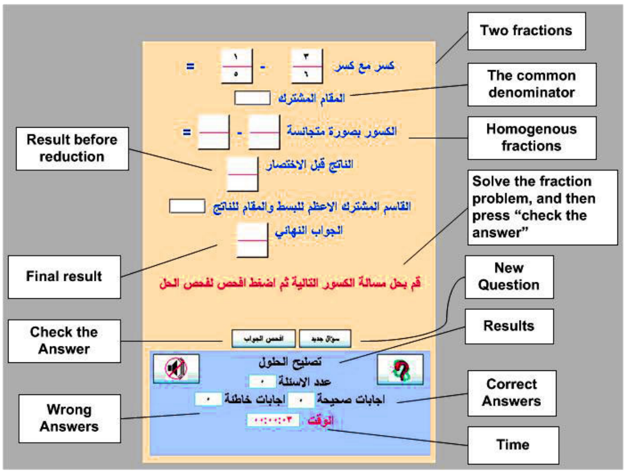

Figure 10. Regular fraction subtraction

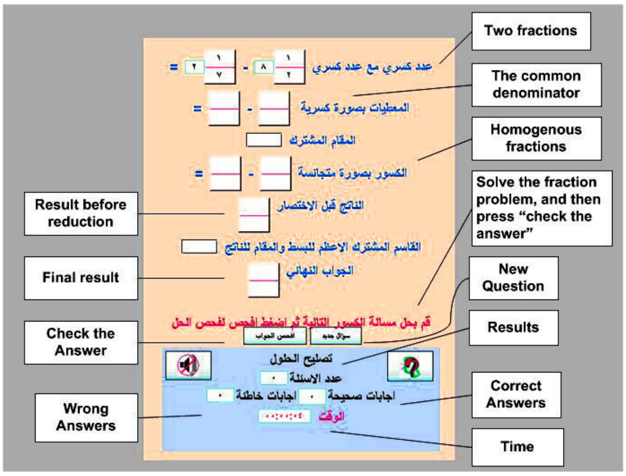

Figure 11. Fraction number subtraction

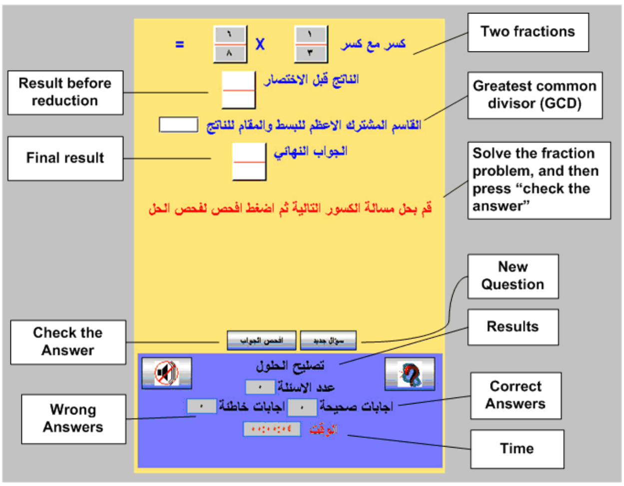

Figure 12. Regular fraction multiplication

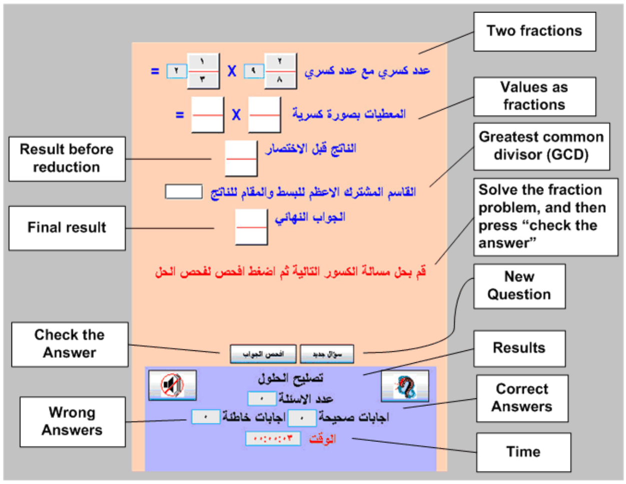

Figure 13. Fraction number multiplication

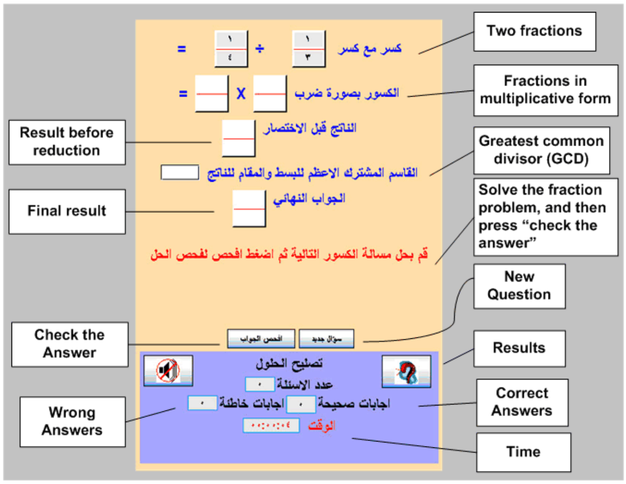

Figure 14. Regular fraction division

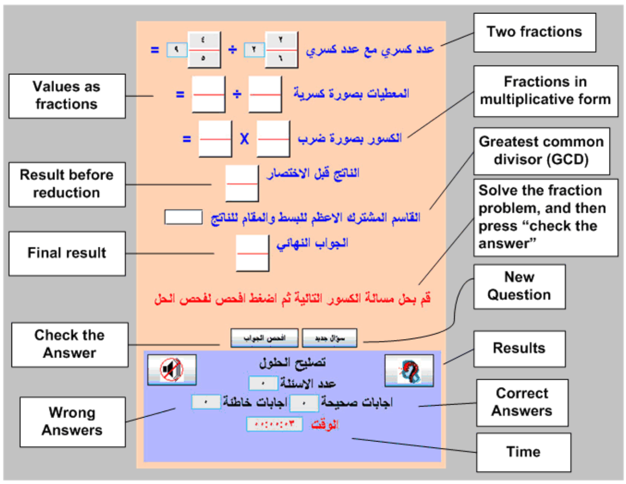

Figure 15. Fraction number division

IV. USABILITY TESTING OF THE EDUCATION SYSTEM

This section, which highlights the merits of introducing e-learning in schools, describes the influence of multimodal-based design of e-learning tools on the students' learning process in the Palestinian National Authority schools achieved by usability tests aimed at investigating the effect of using computerized methods on the achievement of primary grade students in mathematics, in comparison with traditional non-computerized systems of education [2]. There will be a presentation of a sample for comparative evaluation that consists of fifteen students, both male and female; all of them learn at schools of Ramallah district. They were divided into two groups of eight and seven students, so that during the comparative evaluation, both groups had to solve mathematical problems based on the two approaches. The raw data of the experiments were handled statistically by using the Student's test (t-test) [6] and then analyzed by SPSS [7]. Through the usability test, we have concluded that the e-learning education system is superior to the traditional approach. The two approaches were compared with each other by means of an experimental testing, in which some selected usability criteria such as transparency, confidence, effectiveness etc. have been used. The investigation has shown that, on one hand, the use of e-learning has a significant effect on the achievement of students in primary stages; On the other hand, there has been a positive change in the attitudes of the students towards using the computer in the learning process. As result, it is recommended we carry out more experimental studies on the role of the computers in education for all disciplines of learning. Moreover, researchers would also like to emphasize the necessity for the development of a computerized syllabus for schools in all the disciplines of education.

This evaluation was divided into two parts: the first part was concerned in finding out some usability differences between the four arithmetic operations: addition, subtraction, multiplication and division, provided by the e-learning education system. Results and guidelines achieved through this evaluation help and orient software system developers and user-interface designers in their tasks of both developing of newer e-learning products or optimizing existing ones; whereas, the second part has been oriented to compare between the e-learning education system and the traditional learning approach using textbooks. The number of subjects was fifteen, and the t-test technique is suitable for subject numbers less than thirty, thus our choice was for the simple t-test and not for the complicated ANOVA. The experimental testing and the interviews took place in a primary school located in the Ramallah district of education of the Palestinian Authority. The raw data for this experimental testing have been partly obtained by means of subjective evaluation that was being accomplished by means of interviews and questionnaires. This kind of evaluation is suitable to compare two different conditions, as in our case, the non-computerized approach (the traditional textbook) and the contemporary one (the e-learning education system). During this usability testing, students had to rate questions in seven-point scales. The other part of raw data has been obtained objectively by recording the students' interaction with the computer in an experimental session.

The statistical outcome should be analyzed and reviewed by the usability engineers and the system designers, so that the final results helped in revising and optimizing the design of the interactive software system on one hand; and the system designers could have defined new or corrected existing design guidelines for future e-learning tools on the one hand. As useful means for comparing mean values of two sets of numbers, usability engineers have the opportunity to select between either the Student's test (t-test) [17] or one-way ANOVA, through which a comparison can be carried out, providing us with a statistic for evaluation exposing the statistical significance of the difference between two means. During a usability testing session, the usability engineer explains to the subject (the student) all operations related to real fraction in very simple and clear way. The education tool represents the arithmetic operations tailored to the students' needs, so that this encourages them for e-learning and studying via the graphical user-display. Several perception-ergonomic aspects were taken into account whilst developing and designing the e-learning education tool. However, the perception of ergonomics is concerned with designing aspects such as color, shape form, dimension and allocation [18]. Depending on the operation type, the scenario time varies between 3 minutes and 20 minutes. The e-leaning education system was introduced for the students before having begun actual experiments consisting of the different scenarios. This introduction included the following activities: entering into the main page, choosing one of the real fraction operations, reading the explanation and examples for a set of offered examples; and solving the given exercises for the selected operation from the easy to the hard. Introducing some examples through the e-learning system might have contributed to skip possible barriers between the students and the computerized education system; as well as reduced students' insecureness regarding contemporary techniques. During a scenario, the students had to solve three different problems for each operation.

In our comparative evaluation, the two education approaches: the traditional education way and the e-learning education system, the subjects (students), and the different scenarios represent the independent variables or factors. This designation comes from that these terms are independent from each other. The dependent variables are the different criteria such as transparency and efficiency used to compare the factors with each other. They are divided into two parts: objective and subjective. The objective part, which will be recorded automatically by the software, takes into account how the subjects interact and deal with the different systems. The subjective part reflects the user’s impression about the interfaces, and it can be acquired by surveys and interviews. In this investigation, various evaluation criteria were used to test the usability of the education system such as effectiveness and efficiency, transparency, navigation, error management, stress, confidence etc. After finishing an experiment with a student, the student had to answer the following questions leading to the different subjective criteria: "I like to use computer", "I find the system commands easy to use", "I find learning fraction using computer more interesting for learning", "I am competent with and knowledgeable about the system", "I feel that speed of performance is reducing the time of performing a specific function", "I find large of information that can be

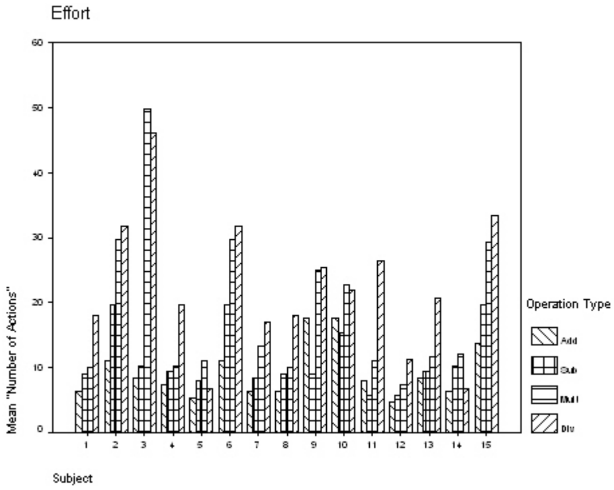

Figure 16. Comparison between the basic operations according to the number of actions: keystrokes and mouse clicks [2]

displayed on screen", "When I use the system sequence of screens, I can forward to the next screen or back to previous screen clearly", "When I get an error message, I find that it is helpful in identifying the problem", "The graphical presentation of fractions helps me to understand the real fraction math" etc. It should be noted that the students were asked these questions in Arabic.

In a usability testing, evaluators had to form a hypothesis as a start point for proving their expectation. However, for this evaluation, a hypothesis can be stated as the follows: "When students solve mathematical problems using the e-learning system, they will be faster than using the educational approach based on a math textbook". In this case, the null hypothesis H0 is that there are no differences between the periods of time necessary for learning. This hypothesis clearly identifies the independent variable for our experiment: the variation of the learning style; hence, the independent variable has two levels: e-learning and traditional. It is obvious that the term "faster" is equivalent to "solving time", "time needed" or "time to learn". In this experiment, speed at which a student can accurately solve a problem using one of the two approaches was considered, as an indication of its superiority. Our dependent variable, therefore, is the time needed to solve a mathematical problem. It has been noted that during a session, a student had to solve 3 mathematical problems (scenarios) for every learning style. In order to avoid effects caused by learning, the users were divided into two groups with each group taking a different staring condition. After having manipulated the raw data by SPSS which also allows producing of both tables and graphs, the statistical results achieved by the comparative evaluation can be interpreted. It has been shown that for most scenarios the division and multiplication operations were the hardest for the students as they require the maximum actions to solve the problems, while the addition and subtraction operations take the minimum number of interaction activities. Fig. 16 represents a comparison between the mean values of the four basic operation, addition, subtraction, multiplication, and division regarding the number of actions in the form of keystrokes and mouse clicks [2]. Such new knowledge and experiences obtained by the evaluation can be utilized in the setting up of novel e-learning tools for scientific topics. Thus, we reject the null hypothesis that there are no differences and conclude that the division operation by the e-learning education system is more effectively executed than with textbooks. This result is valid for all the other operations that were experimentally proved similar methods and techniques like the ones shown in this section.

V. CONCLUSION

It has been shown how we can design educational software tool for the primary grades in real factors in mathematics. The objectives of such a mathematical program for school students in primary stages are to encourage them to study mathematics through introducing a lot of examples and exercises that aid them to understand the basic operations on real fraction, as well as to present and explain the subject in a clear and user-oriented manner through visual illustrations and alternations. Besides taking various human factors into account that are of great significance for designing multimodal-based e-learning tools such as consistency of data display, efficient information assimilation by the user, minimal memory load on user, compatibility of data display with data entry, flexibility for user control of data display etc., the development of the educational software tool was oriented to multiple design issues acquired by e-learning theory principles and methodologies of interactive multimedia. It is obvious that the e-learning tool guides and navigates the student in the learning process realized as stages or grades, where every grade - more or less - comprises the previously mentioned phases of instruction: presenting information, guiding the learner, practicing and assessing learning. Moreover, the four methodologies of interactive multimedia: tutorials, hypermedia, tests, and web-based learning, implemented in designing the educational tool complement each other and play in harmony with students. Mathematically, the stages are ordered as follows: the first stage deals with the regular fractions, the second and the third with the visual introduction of the concept of fractions, the fourth with the visual mediation of fraction equivalence and comparison, the concept of regular fraction addition and fraction number addition; and the concept of regular fraction subtraction and fraction number subtraction; and finally, the fifth and the sixth grades with the concept of regular fraction multiplication and fraction number multiplication as well as the concept of regular fraction division and fraction number division. In order to check the appropriateness of the e-learning tool concerning both usability criteria and educational measurement aspects, a comprehensive evaluation was being carried out [2]. Through this usability test aimed at investigating the effect of using computerized methods on the achievement of primary grade students in mathematics, compared with traditional non-computerized systems of education, the advantages of introducing e-learning in schools and describe its later impact on the students' learning process in the Palestinian National Authority schools have been not only raised, but fresher knowledge about evaluation of educational software for primary stages has been acquired.

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